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COMPLEX GEOLOGICO-GEOPHYSICAL INVESTIGATIONS OF THE CRUSTAL STRUCTURE IN THE ZONE OF TRANSITION BETWEEN THE ASIATIC CONTINENT AND THE PACIFIC OCEAN

S U M M A R Y

1. The striking difference in the crustal structure under continents and oceans - in thickness as well as composition- made the investigation of the transition zone between them of great importance. The USSR program for the IGY includes the investigation of the deep crustal structure in the Kurile-Kamchatka zone of transition. The Kurile-Kamchatka zone of transition between the Asiatic continent and the Pacific ocean is one of the geologico-geophysically most interesting regions of the globe. Here we have the Kurile island arc which is bordered from south-east by the deep Kurile trough. It includes also the belt of the strongest in the USSR seismic activity with origins of earthquakes arising at depths ranging from the smallest down to 600 km. In this region of the USSR volcanism is also most strongly developed. The natural geophysical fields (gravitational and magnetic) in this zone show sharply pronounced anomalies.

2. M e t h o d s o f i n v e s t i g a t i o n. A angular feature of the work of the Pacific expedition is the use of a wide complex of methods of investigation as well as comparatively detailed observations (for regional work). The geophysical investigations are carried out by seismic, gravimetric and magnetometric methods.

Seismic shooting measurements were combined with observations of weak local earthquakes. At sea acoustic and hydrological determinations were added. Geophysical investigations of the crustal structure are complemented by geologic observations and laboratory examinations of samples of rocks. The region under

Investigation includes the Okhotsk sea with its north-west coast, the island of Sakhalin, the Kamchatka peninsula, the Komandor and Kurile islands and the adjacent parts of the Pacific ocean including the Kurile trough and also the south-west part of the Bering sea. The work was planned for two seasons.

3. S e i s m i c o b s e r v a t i o n s. Seismic observations were carried out by the method of Deep Seismic Sounding (DSS). The main features of this work are: 1) The use of mobile shooting points and stationary recording points, 2) A combination of sea and land observations.

In 1957 two DSS profiles were made crossing the southern part of the Okhotsk sea along lines running from Sakhalin to the islands of Iturup and Urup and three profiles crossing the Kurile trough (Tuskarora). These run from the islands of Iturup, Urup and Simushir and extend into the ocean for about 650 km. In the region of the island of Iturup an area survey was also carried out consisting of a fan-shaped system of profiles made from sea and land observations. 700 shots were fired and profiles of a general length about 3300 km were made. Along each profile systems of unreversed, reversed and overtaking distance-time curves were obtained.

From the DSS records waves were picked out corresponding to the "granitic", "basaltic" and subcrustal layers. Depending on the geographic location of the profiles, three types of distance-time curves for these waves differing in the absolute arrival times stand out: the Pacific, the Okhotsk- sea and island-types (the last for Sakhalin and the Kurile islands).

4. G r a v i m e t r i c o b s e r v a t i o n s. Along the lines of the DSS profiles gravimetric observations were also carried out by means of special gravimeters with highly damped systems. Observations were made on ships on three gravimeters simultaneously and were correlated with the land observations. The gravity anomaly of 250 mgl above 100 mgl (a relative minimum) and then sharply increases above the Kurile trough reaching at the beginning of the deep-water plateau a value of 400 mgl.

5. Magnetometric observations. These were carried out as an aeromagnetic area survey. The survey was made by means of a AChM-25 station carried by a hydroplane flying at a height of 2000 km above the sea level. From these observations a diagram of the magnetic anomalies was drawn. Above the Okhotsk sea, between South Sakhalin and South Kurile islands, the magnetic field is little disturbed and mainly positive. Above the Kurile are, against a background of negative values local positive anomalies appear, reaching up to 700 gm. South-east of the Kurile ridge there is a zone of large positive anomalies. When the deep-water plateau is reached, an abrupt change in the character of the anomalous magnetic field takes place. The line of anomalies runs distinctly in the north-eastern direction.

6. S e i s m o l o g i c a l o b s e r v a t i o n s. In order to investigate the weak local earthquakes of the Kurile islands, a net of 5 provisional regional seismic stations of a higher sensitivity was set up by the expedition on the island of Iturup, where the most detailed DSS data were obtained. The stations were equipped with seismographs of the VEGIK type having a natural period of 0.7 sec. The magnification of the apparatus was about 16000. It is believed that a joint treatment of the DSS data and the observations of the local earthquakes should give a more detailed picture of the crustal structure. The observations of earthquakes will also enable us to investigate the location of earthquake origins in space as well as the connection between the seismicity of the island region and the deep crustal structure, volcanism and tectonics.

7. G e o l o g i c o b s e r v a t i o n s. Geologic work should throw light upon the present structural conditions in the region under investigation, the history of its tectonic development and, in particular, upon its up to date history. Paleogeographic diagrams will be drawn which will enable us to clarify the history of the vibrational movements of parts of the land adjacent to the ocean and describe more accurately the history of forming the depressions of the Okhotsk and Bering seas

as well as of the adjacent portions of the Pacific ocean. Diagrams are being drawn of the present crustal structure in the region under investigation and an attempt is being made to establish a connection between the structure and present day movements on one hand and seismicity on the other. The treatment of the data obtained by the expedition is not yet finished and only preliminary results can be communicated.

8. Preliminary data on the crustal structure in the direction S.Sakhalin- S.Kurile islands - the ocean. The crustal structure in the region investigated by the expedition in 1957 can be described as follows: 1) The thickness of the crust increases sharply under the Kurile islands and the adjacent shallow parts of the Okhotsk sea and Pacific ocean. The crust here is close in structure to that of the continental type and consists of three layers: the sedimentary, granitic and basaltic.2) In the eastern part of the western slope of the Kurile trough wedging out of the granitic layer is taking place. Further into the ocean the crust consists only of a basaltic layer thinly covered by sediments. In the ocean the thickness of the crust, including the column of water, is of the order of 12-17 km. 3) In the Okhotsk sea there is a difference in structure between profiles I and VI. Along the southern profile (I) we have a continental crust of a maximum thickness about 28 km consisting of three layers, whereas along the northern profile (IV) the crust is thinner-maximum thickness about 20 km- and contains no distinct granitic layer.

The obtained results are in good qualitative agreement with the gravimetric data.

The obtained data show that the crustal structure in the transition zone is extremely complicated. We have here in fact three types of crust: a properly continental crust observed under the islands and adjacent shallow parts of the sea and ocean; a oceanic crust which is typical for the ocean bed and an intermediate crust characteristic for the southern deep-water part of the Okhotsk sea.

In 1958 the volume of work of the expedition by all above mentioned methods is almost doubled.

At the present time sea and land observations are being carried out by the expedition.